April 27, 2009 Presentation to
The Advisory Committee on Offshore Energy Exploration

by Charles H. (Pete) Peterson
University of North Carolina at Chapel Hill
Institute of Marine sciences
Morehead City NC 28557
cpeters@email.unc.edu

IMPLICATIONS OF COASTAL ENERGY PRODUCTION ON IN-SHORE AND NEAR-SHORE ECOSYSTEMS

I. Relevant Experience of CH Peterson:

(1) One of 5 Members of North Carolina Environmental Sciences Review Panel of U.S. Dept. of Interior (MMS) – 1990-1991

(2) Collaborator in GOOMEX – an MMS study of the long-term environmental impacts of decades of oil production around drilling platforms in the Gulf of Mexico – 1993-1996

(3) Scientific Review Panel Member for the Exxon Valdez Oil Spill Trustees – 1989- 2009

(4) Currently a Principal in legislatively mandated UNC Study of the Potential for Development of Wind-Over-Water Power in NC

II. North Carolina Environmental Sciences Review Panel of U.S. Dept. of Interior (MMS)

A. Panel members – John Costlow (Duke), Mike Ohrbach (ECU-Duke), Kenneth Brink (Woods Hole Oceanographic Institution = WHOI), John Teal (WHOI), Charles Peterson (UNC-CH)

B. Panel Charge from DOI

a. Did MMS follow the legally proscribed procedures in offering oil-and-gas leases for sale off the NC Outer Continental Shelf (OCS)
b. What does the panel recommend as remedies in the case of some deficiency in environmental science knowledge

C. Panel Answers

a. Three areas of environmental science required by law to conduct sufficient risk assessment to support leasing decisions
    i. Physical transport models – adequate to assess risk of transport of spilled oil to shore
    ii. Biological resources – characterization of important and valued biological resources potentially at risk
    iii. Socio-economic characterization of coastal communities potentially influenced by oil-and-gas development
b. Panel conclusions
    i. All risk assessment needs to be conducted up front before lease sales because despite additional environmental review before MMS approval is granted for production phase drilling has never been denied at that stage only conditioned
    ii. Information then (1990-1991) available is insufficient to conduct proper risk assessments in all three areas of environmental science required before leasing even though leases had already been offered and purchased on the NC OCS
        1. Physical transport modeling – existing models were inadequate because they were based on monthly mean flows, which failed to include Gulf Stream eddies and rings that spun off and result in transport to shore (exemplified by the red tide outbreak in 1987 that was transported from SW Florida via the Gulf Stream to Bogue, Back, Core Sounds in NC via eddies in waters offshore of NC)
        2. Biological resources at risk – existing information was inadequate on the unique biotic communities associated with "The Point" area off Cape Hatteras, where the tropical Gulf Stream and boreal Labrador Currents meet and mix, resulting in high productivity, density, and diversity, and on the communities and valuable organisms, including many threatened and endangered species, associated with the floating *Sargassum* weed
        3. Socio-economic character of NC coast – existing information on social and economic nature of NC coastal communities that may be influenced by oil and gas development was seriously incomplete, making any dependent impact analysis unreliable
c. Outcome of the panel

    i. Expression of need for more research to fulfill legal obligations for each of the three areas of environmental science
    ii. Ultimately contributed to congressional moratorium on oil-and-gas exploration and development on the NC OCS
    iii. Clearly resulted in additional new research (eg, NOAA NURC studies by Steve Ross of biological resources around The Point and

deep-water corals at the shelf break) , but unclear to me if the additional research is sufficient to address all deficiencies

III. GOOMEX study (1993-1996) of environmental impacts of decades of oil production around drilling platforms in the Gulf of Mexico

A. MMS study headed by Chuck Kennicutt of Texas A&M University

B. Synthesis paper -

Peterson, C. H., M. C. Kennicutt, II, R. H. Green, P. Montagna, E. N. Powell, and P. Rosigno. 1996. Ecological consequences of environmental perturbations associated with offshore hydrocarbon production: a perspective from study of long-term exposures in the Gulf of Mexico. Canadian Journal of Fisheries and Aquatic Sciences 53: 2637-2654.

C. Environmental and ecological impacts of oil production processes
   i. Bottom invertebrate community is modified out to a distance of 100-200 m from the drilling platform, with effects caused both by heavy metal toxicity from impurities in barite drilling mud and organic contamination from low-level hydrocarbon releases and organic materials shed from fouling growth on the platform
   ii. Oxygen depression is evident in the water column and increased benthic respiration is persistent near the platform, driven by microbial decomposition of increased organic loading
   iii. Produced waters discharged during separation of product from water may induce some toxicity
   iv. No detectable influence on fish community, but fish mobility prevents a strong test and bottom trawling is inadequate to test for an “artificial reef” effect

IV. Long-term effects of the Exxon Valdez oil spill on shoreline ecology

A. Multi-million dollar study of the long-term (up to 20 years) effects of oil contamination of coastal environments after the 1989 Exxon Valdez oil spill

B. Synthesis papers –

Peterson, C.H. 2001. A synthesis of direct and indirect or chronic delayed effects of the Exxon Valdez oil spill. Adv. Mar. Biol. 39: 1-103.

Peterson, C.H. S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. Ballachey, and D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302: 2082-2086.

C. Acute impacts of the oil spill

a. Killed unprecedented numbers of seabirds and waterbirds because feathers were oiled and lost their insulating capacity plus preening led to ingestion of toxic oil
b. Killed hundreds of marine mammals, including over 800 sea otters, and many killer whales, and harbor seals because fur was oiled and insulation capacity was lost plus preening led to ingestion of toxic oil
c. Shoreline algae and invertebrates suffered high mortality from smothering by oil and toxicity
d. Oil clean-up activities used pressurized application of water jets killed more shoreline invertebrates than the spilled oil itself
e. Fisheries were closed because of contamination of the product and public perception that Alaskan fish was contaminated
f. Terrestrial species like eagles and bears were killed by ingesting oiled carcasses and by preening oiled feathers or fur

D. Chronic impacts of the oil spill
    a. Oil in shoreline sediments that were protected from physical disturbance and oxygenation remained without weathering in toxic form for two decades and continued to contaminate bottom invertebrates and cause elevated mortality for at least a decade in the diving ducks, sea otters, oystercatchers, and other vertebrate predators that fed upon them
    b. The diving ducks and marine mammals feeding in contaminated sediments suffered chronic mortality for over a decade
    c. Fishes that laid eggs in sediments also showed population losses over several years as oil penetrated egg membranes and killed the eggs and as oil limited growth rate of small fish which led to high mortality and fewer fish returning as adults to reproduce and to be harvested in fisheries
    d. Toxicity testing on the partially weathered oil demonstrated that this residual oil in chronic exposures was far more toxic and at lower concentrations when in dispersed in water than fresh oil, implying that much greater loss of eggs and other susceptible life stages of fishes and invertebrates is routinely happening from even small oil spills and repeated exposures in stormwater than had been assumed before

E. Implications for oil-and-gas development in North Carolina
    a. Including small spills, the EPA reports that an oil spill occurs in the U.S. at a rate of 70 times per day
    b. Most of these spills occur during transport of the oil, although the largest are associated with accidents like storms or collisions or explosions
    c. Double-tanking of oil tankers promised as a precautionary remedy after the Exxon Valdez spill is incomplete
    d. The analogous shoreline environments at risk to long-term contamination leading to fish and wildlife mortality in NC are

estuarine salt marshes, oyster reefs, and seagrass beds because oil floats, then penetrates into sediments when stranded during low tide, where it can become protected from oxygenation and weathering

i. The salt marsh is the environment of greatest concern because it is (1) entirely intertidal in elevation where oil will come readily to reside, (2) physically quiescent such that sediments are unoxygenated and thus ideal reservoirs for persistent oil contamination, and (3) the coastal habitat of greatest significance of all for fish and wildlife production, water quality maintenance, shoreline stabilization, and other ecosystem services

ii. Impacts of oil on salt marshes persist for decades to centuries, as discussed in the classic review by Teal & Howarth (1984):

Teal, J., and R. Howarth. 1984. Oil spill studies: a review of ecological effects. Environmental Management 8: 27-44.

iii. Follow-up study of Cape Cod salt marshes oiled 40 years ago by a spill from the barge *Florida* demonstrated that a layer of toxic PAHs was still evident at soil depths of 1-20 cm, the most important animal of the marsh, fiddler crabs, which dig burrows into the soils and process organic matter and energy, were still depressed in abundance, dug burrows only half as deep as normal, and exhibited abnormal sluggish behavior. The marsh plants themselves were also still dwarfed in size.

iv. Estuarine oyster reefs, which are also at intertidal elevations south of Cedar Island and thus experience coating by oil as the tide recedes, are now targets of active restoration in recognition of their ecosystem services to water quality, fish habitat, as a fishery themselves, and as shoreline stabilizers. They stand at risk from development of local oil development.

v. Seagrass beds (SAV) represents a vital nursery habitat for shrimp, bay scallops, and numerous fishes, one that has already suffered great decline and is aggressively protected from further injury and loss in coastal management programs. This shallow habitat is also at risk from spilled oil and studies show multi-year losses of natural function of SAV after oil spills.

e. Ocean beaches represent the other major shoreline habitat at high risk from any oil spill off the NC coast

i. This habitat could be considered the economic engine for the entire coastal economy of North Carolina

ii. Ocean beaches represent a high-energy environment such that natural clean-up of spilled oil occurs rapidly – within a year

iii. Nevertheless, beaches are typically closed for any public use for months after an oil spill, commercial fishing is closed, and economic effects are huge

f. On-shore development of petrochemical industry where oil pipe lines come ashore is incompatible with existing NC coastal economies based on tourism, retirement, and fishing

i. Air pollution potentially leading to ozone violations

ii. Water pollution from cumulative effects of small spills

iii. Truck traffic increased on the local roads

V. Potential for Wind Power development over water in coastal North Carolina is favorable and could help enhance production of domestic energy by using a renewable source with minimal release of greenhouse gasses